Naval Submarine Medical Research Laboratory

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THE EFFECT OF BLINKING ON SUBSEQUENT DARK ADAPTATION

by
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Released by
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Report Number 1170

U.S. Coast Guard
Work Unit NIPR-Z51100-9-0002

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SUMMARY PAGE

The Problem
To test whether or not an initial period of blinking facilitated subsequent dark adaptation.

The Findings
Blinking did not appreciably improve the speed of dark adaptation for any one of 10 subjects. It somewhat interfered with the course of adaptation of three subjects, because it produced an afterimage of the light adaptation screen.

Application
Blinking will not significantly reduce the time required for dark adaptation.

ADMINISTRATIVE INFORMATION

This investigation was conducted under U.S. Coast Guard Work Unit No. NIPR-Z51100-9-0002. It was submitted for review on 5 September 1990, approved for publication on , and has been designated as Naval Submarine Medical Research Laboratory Report Number 1170.

The Effect of Blinking on Subsequent Dark Adaptation

INTRODUCTION

Night vision is extremely important for all operational forces, no less so for the submarine force. Periscope operators must be able to see at night, and great care is taken to ensure that they will be dark adapted when necessary. The crew in the control center routinely begins to dark adapt well in advance of nightfall. It is, thus, impossible to imagine that a submariner will not be dark adaptated when necessary.

Nevertheless, if the dark adaptation process could be speeded up, it would add to the efficiency of submarine operations. For this reason, a claim by Stryker (1990) that an individual will achieve dark adaptation very quickly if he blinks his eyes rapidly and forcefully for 15 to 30 seconds has aroused some interest. The claim was that this technique works for about half of those individuals who have tried it. The Commander of the U.S. Submarine Force in the Pacific informally requested an evaluation of this claim by NSMRL (Goad, 1990).

There does not appear to be any compelling physiological basis for expecting blinking to facilitate dark adaptation. Dark adaptation has an initial very rapid (1 or 2 seconds) neurological component (Baker, 1963) followed by a slow biochemical component (30 to 45 minutes) (Rushton, Campbell, Hagins and Brindley, 1955; Wald, 1959). The former does not require 15 seconds or more to be affected, and it is difficult to see how a biochemical reaction--the transformation of the photochemical rhodopsin in the photoreceptors-- could be speeded up from several minutes to several seconds. It is conceivable that energetic blinking might increase the flow of blood, but this should not affect the chemical transformation of the rhodopsin.

There is one interesting phenomenon which relates to Stryker's technique. It is well known that an afterimage which has faded can be brought back by blinking (Troland, 1917; Brindley, 1962; Barlow and Sparrock, 1964). The explanation is not clear. But any technique which reintroduces afterimages should elevate visual thresholds and interfere with dark adaptation rather than facilitate it. In this study, we have compared the rate of dark adaptation with and without a preliminary 30-second period of blinking.

METHOD

Subjects

Ten staff members of the laboratory (eight men and two women), aged 21 to 60, served as subjects. All had or were corrected to at least 20/25 vision. Most had considerable experience as experimental observers.

Apparatus

The test light was a circular stimulus subtending 30 min visual angle at the viewing distance of one meter. It was presented 10 deg to the left of a pinpoint red fixation light. The light source was a projection bulb whose luminance was varied with neutral density filters;

its dominant wavelength was adjusted to 500 nm with a Corning glass filter. The test light was exposed for 0.5 sec intervals with a Lafayette Tachistoscope Shutter attachment, Model 43010. The subjects were light adapted to a ground glass screen illuminated to 500 C/m^2 and subtending 40 deg visual angle on a side.

Procedure

The subject was first light adapted for three minutes. The lights were extinguished, and one of two procedures was followed. Either he (or she) stood quietly in the dark and looked downward for 30 seconds or else was instructed to look downward and blink rapidly and forcefully for 30 seconds. Then he sat down, occluded his left eye, placed his chin in a chin-rest, and acquired the fixation light. The experimenter then called out two time intervals in close succession and exposed the test stimulus for 0.5 sec during one of them. (The subject could hear the shutter being opened during both intervals, but the light was blocked during one of them.) The luminance of the test stimulus was initially set below his threshold, and this procedure was repeated at 15 sec intervals until the subject reported that he could see the stimulus and reported it in the correct interval. The luminance of the test stimulus was then lowered, generally by 0.1 log unit, and the procedure was repeated. This was continued for 15 minutes. Each subject was tested twice, once after blinking and once without the blinking. Half the subjects were tested first without blinking; the other half were tested first after blinking.

RESULTS AND COMMENT

Figure 1 shows the dark adaptation curves with and without the blinking for each subject. The subjects are in order of age from KJ, the youngest to SL, the oldest. Each graph shows the time required by each subject to see the test stimulus at a progressively reduced luminance level. The lower and steeper the curve, the more sensitive and faster the subject is dark adapting. If the blinking facilitated dark adaptation, that curve (filled circles) would be lower than the curve obtained with no blinking (open circles). If the blinking produced complete dark adaptation in 30 seconds, then its curve would be a horizontal line at the lowest intensity which that subject was capable of seeing. To test if the regression lines were significantly different, Z-scores were calculated for both the intercepts and slopes (Cohen and Cohen, 1983).

There is little indication that the blinking reliably facilitated the dark adaptation. The dark adaptation curves are faster for two subjects (MS and EN); the pairs of intercepts for both subjects are significantly different according to Z-scores ($p < .03$). But for three of the subjects (CS, JD, and TB) the blinking significantly retarded adaptation during the initial stages. The intercepts were significantly different for CS ($p < .0001$) and JD ($p < .0001$); although the intercepts were not significantly different for TB, the slope of the dark adaptation curve after blinking was significantly slower ($p < .0001$).

Two of the subjects gave an explicit reason. It was that the blinking main-

Abstract

This study tested whether or not dark adaptation is facilitated by blinking for a short time at the beginning of the dark adaptaion. The course of dark adaptation was measured for 10 subjects both with and without an initial period of blinking for 30 seconds. The blinking did not improve the rate of dark adaptation.

tained an afterimage of the light adapting screen and made it harder to detect the test stimulus.

There is no relationship between the ages of the subjects and the effects of the blnking. Of the two whose adaptation was slightly faster, one was 23 and the other was 51; the three whose adaptation was retarded by the blinking were 31, 37, and 45.

There is, thus, little indication that blinking facilitated the dark adaptation. In no case is the dark adaptation curve associated with the blinking appreciably lower than the control curve, and, of course, the blinking did not produce complete dark adaptaion. Stryker claimed that only about half the individuals show a positive effect. But if the positive effect is no greater than that exhibited by the two subjects in this study, it is not of practical significance on submarines in view of the present operational procedures.

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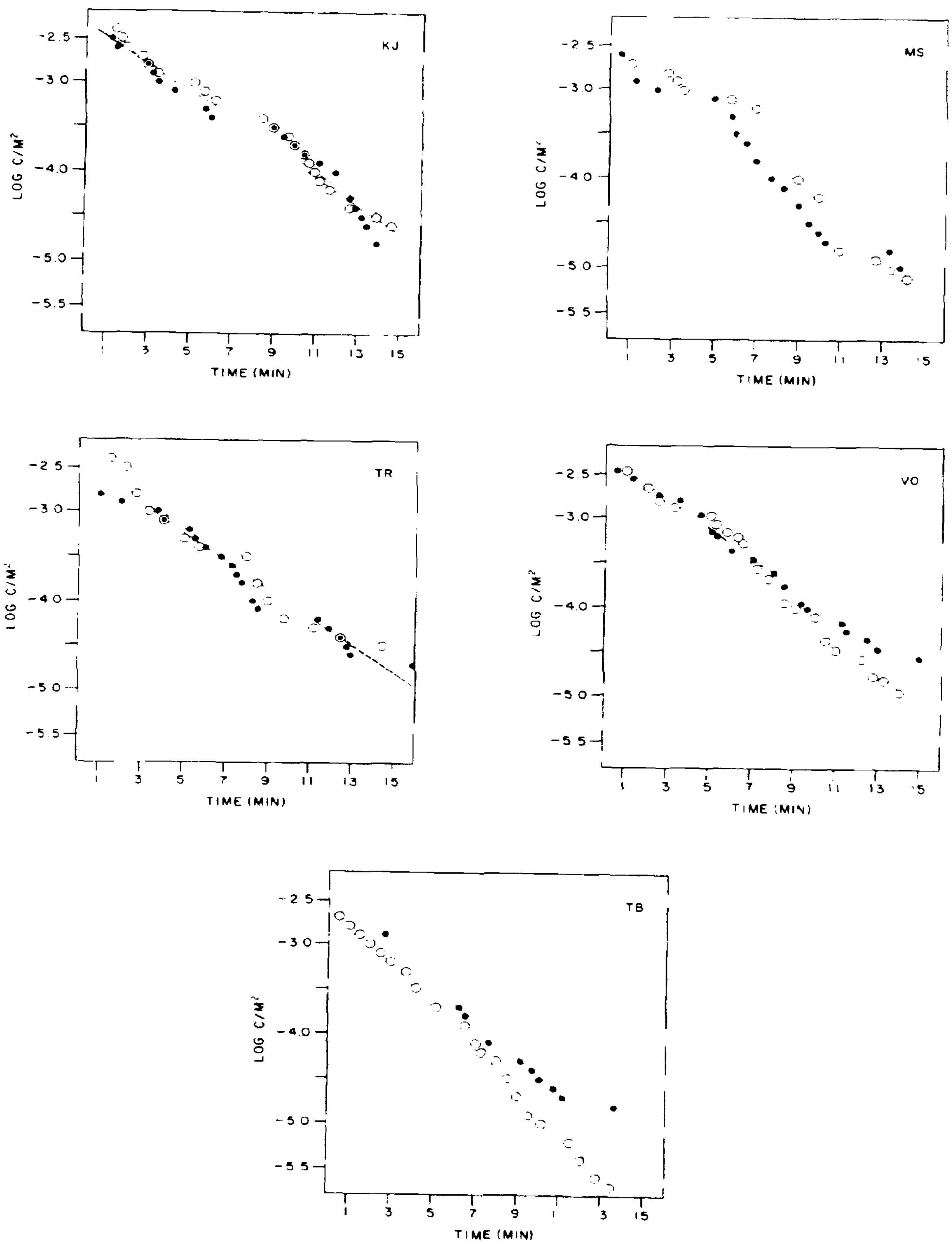
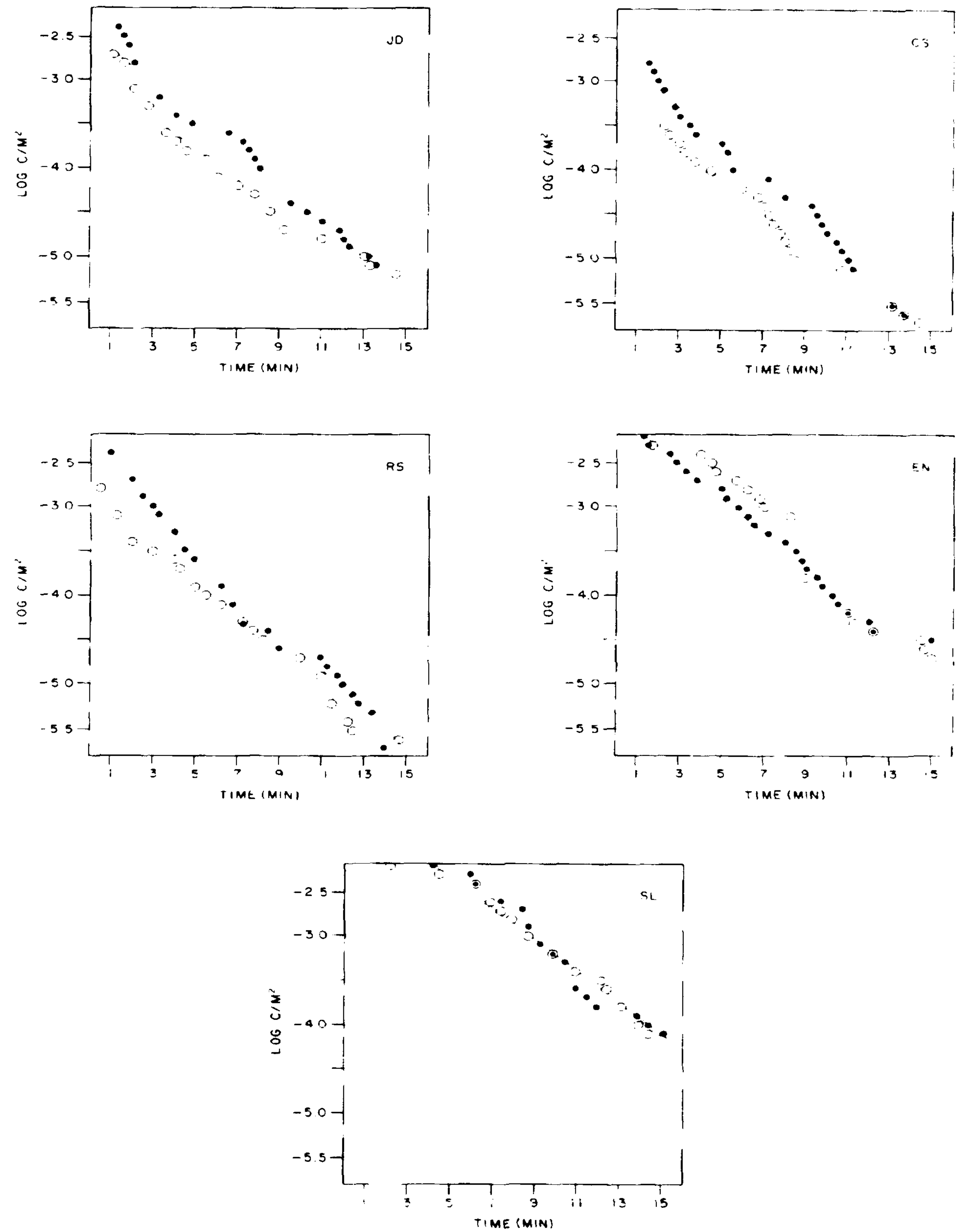


Fig. 1. Times taken by each subject to achieve various levels of dark adaptation following blinking (filled circles) or not blinking (open circles). The regression lines are least squares solutions. The subjects in order of increasing age were KJ, MS, TR, VO, TB, JD, CS, RS, EN, SL.


JD
CS
RS
EN
SL
LOG C/M²
TIME (MIN)
-2.5
-3.0
-4.0
-5.0
-5.5
1
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5
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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

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